Submission Title:

Trends in Asian summer monsoon anticyclone dynamical diagnostics in reanalyses

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Abstract

The area of the Asian summer monsoon anticyclone (ASMA), as defined by contours of Montgomery stream function (MSF) on isentropic surfaces, has been increasing over at least the last four decades. Here we analyze the relationship of the trend in ASMA area to trends in dynamical diagnostics in the ASM region, both inside and outside the ASMA, for 1979 through 2020 in the MERRA-2, JRA-55, and ERA5 reanalyses. Trends in geopotential height (GPH) and temperature (from which MSF is calculated) indicate that MSF increases are dominated by increasing temperature (GPH) at levels that are primarily in the troposphere (stratosphere). Trends in MSF, GPH, and temperature are much less clear within the ASMA circulation than those for the entire ASM region, suggesting that other mechanisms, besides the direct effects of increasing tropospheric temperatures, are at play. To further explore these results, we present trends in lapse rate and dynamical tropopause altitudes, easterly and westerly windspeeds bounding the ASMA, and potential vorticity. Overall, weak or inconsistent trends inside the ASMA in most diagnostics likely arise from a complex interplay of mechanisms in this region (which spans tropospheric/stratospheric and tropical/midlatitude conditions), and suggest that the previously reported area trends do not necessarily indicate an increase in “intensity" of the ASMA. In regions both with and without robust trends in dynamical diagnostics, trend results are typically consistent between the three reanalyses studied even when there are biases in the magnitudes of those diagnostics. This generally good agreement indicates that these reanalyses are suitable for more detailed studies needed to fully understand the mechanisms for trends in the ASMA.